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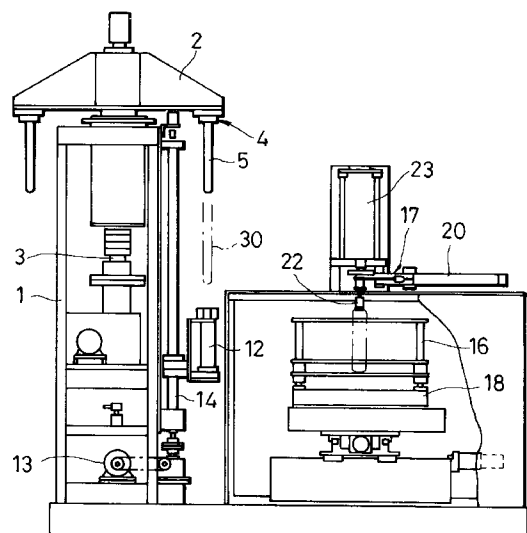
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(54) **Apparatus for testing a tube for its resistance to internal pressure.**

(57) An apparatus for testing a tube for its resistance to internal pressure, has : an expandable hollow elastomer body (5) with one open end ; a test head (8), connected to the elastomer body (5) to provide the expandable elastomer with pressurized fluid medium ; a holder (12), disposed below the test head, to vertically move a tube to be tested into a location in which the expandable elastomer is inserted into a tube ; and a transfer mechanism, arranged beside the holder (12), to provide the holder with a tube from a rack (16). The apparatus according to the present invention can automatically and continuously test numerous tubes for resistance to internal pressure ; overcoming disadvantages of a non-automatic, non-continuous method.

FIG. 1



This invention relates to an apparatus for testing a tube for its resistance to internal pressure. Though various tubes can be tested in the apparatus according to the present invention, a β -alumina tube, which may be used as a solid electrolyte in a sodium-sulfur cell, is particularly suited to be tested in the apparatus according to the present invention.

To test strength of a β -alumina tube to resist internal pressure, one method is known in which the open end of a tube is tightly contacted with a head that provides pressurized water, and then pressurized water is passed into the tube; a tube that does not stand a specific pressure is destroyed. This method, however, has a disadvantage that it takes considerable time and cost to dry the tubes that pass the test.

To overcome this disadvantage, an apparatus for testing a tube for its strength by expanding an elastomer up to a specific pressure inside a tube to be tested, has been disclosed by the present applicants in Japanese Utility Model Application Laid Open No. 1-97241 (1989). In this apparatus it is necessary to cover an elastomer by tubes one-by-one by hand, and it is highly inconvenient to test numerous tubes continuously. Moreover, when an elastomer expands inside a tube to be tested in this apparatus, sometimes the tube is not pushed evenly but to one direction, and an area close to the open end in the tube contacts a metallic part outside the tube in the apparatus to result in scratches and damage in the area of the tube.

According to the present invention, there is provided an apparatus for testing a tube for its strength to resist internal pressure, comprising: an expandable elastomer having a hollow body with one open end; a test head, connected to the expandable elastomer, to provide the expandable elastomer with pressure using fluid as a medium; a holder, disposed below the test head, to vertically move a tube into a place in which the expandable elastomer is inserted into a tube; and a transferring mechanism, arranged beside the holder to provide the holder with a tube from a rack.

According to another aspect of the present invention, the apparatus further comprises a plastic sheet, connected to the test head, surrounding an upper part of the expandable elastomer.

According to another aspect of the present invention, the apparatus further comprises a rotary table that is connected to at least two test heads with expandable elastomers, whereby a test head with an expandable elastomer can be replaced with another test head with an expandable elastomer.

Further details are explained below with the help of the examples illustrated in the attached drawings.

Fig. 1 is a front view of the apparatus according to the present invention.

Fig. 2 is a top view of the apparatus according to the present invention.

Fig. 3 is a cross section of a test head with an expandable elastomer.

Fig. 4 is a front view of a holder and nearby parts. The shaded portion designates that the portion shows a cross section.

Fig. 5 is a top view of a transferring mechanism.

In Figs. 1 and 2 the frame of the main body is designated as 1; a rotary table 2 that rotates around a vertical shaft 3 is disposed above the frame 1; and four test heads are connected to the rotary table 2 so that they have a C_4 symmetry with its rotation axis overlapping the vertical shaft 3. In Fig. 1 the position that the test head 4 in the right side of the rotary table 2 is located at is referred to the test position, and the other three test heads 4 are located at waiting positions. In this configuration a test head 4 in a waiting position can promptly replace the test head 4 in the test position by rotating rotary table 2 when, for example, the test head 4 in the test position wears out.

As shown in Fig. 3 a test head 4 includes a main body 8, a metallic part 6, and a metallic fitting 7. The main body 8 contains an open cavity 10 to provide an expandable elastomer 5 with pressurized fluid.

The expandable elastomer 5, which is a hollow sleeve with one open end, is attached to the main body 8 by the metallic part 6 and the metallic fitting 7 so that the hollow space of the expandable elastomer 5 is connected to the open cavity 10 in the main body 8 through a rigid tube disclosed below. In this application an expandable elastomer 5 has a shape like a slender balloon or a tube to pass into a tube 30 to be tested. However, the shape and the size of the expandable elastomer 5 can be modified according to a sample to be tested.

A rigid tube 9 having at least one hole is disposed inside the expandable elastomer 5, and the open end of the rigid tube 9 is connected to the open cavity 10 in the main body 8. After a tube 30 shown in a Broken line in Fig. 3 covers over the expandable elastomer 5, pressurized fluid provided by the open cavity 10 in the main body 8 fills the inside of the expandable elastomer 5 through holes of the rigid tube 9 to expand the expandable elastomer 5 and to exert a specific internal pressure to the tube 30. Water is preferred fluid as a medium to conduct pressure.

During a test a tube 30 is sometimes damaged in an area close to the open end by being pushed in one direction due to uneven expansion of an expandable elastomer 5. To prevent such a damage the inner side of the metallic part 6 is extended downward to some extent, and a plastic sheet 11 is inserted into the space between the extended part of the metallic part 6 and the expandable elastomer 5. The plastic sheet 11 prevents the upper part of expandable elastomer 5 covered by the sheet from uneven expansion, and thus it prevents potential damage in an area close to the open end of a tube 30.

As shown in Fig. 1, the apparatus according to the

present invention contains a vertically movable holder 12 that carries a tube 30 upward and downward, and it also makes a tube 30 contact the test head 4 in the test position. This holder 12 operates by a feed screw 14 driven by a motor 13. As shown in Fig. 4, the holder 12 contains a structure like a tube with a rubber member 15 in its bottom, and this rubber member 15 supports a tube 30 without damaging it. The structure of a holder 12 can be modified according to the shape and the size of a sample to be tested. Moreover, when a tube 30 with low strength is broken during a test, this holder 12 also functions to prevent broken pieces from scattering.

As shown in Figs. 1 and 2, beside a holder 12 is disposed a rack 16 that stores many tubes 30 and a transferring mechanism 17 that picks up a tube 30 to provide the holder 12 with tubes 30 one-by-one. The rack 16 is supported by a table 18 that can move horizontally. As shown in Figs. 2 and 5, the transferring mechanism 17 has an arm 21 that is swung 90 degrees around a shaft 19 by a cylinder 20. A chuck 22 is provided at the other end of the arm 21, and a tube 30 is held by the chuck 22. The structure and the form of chuck 22 is arbitrary. In this embodiment a rubber part is inserted into the open end of a tube 30, and then the rubber part is expanded by pressurized air so that a tube 30 is held by the friction force between the rubber part expanded and the portion of the tube in contact. An arm 21 is moved upward and downward by an elevating mechanism 23.

It will be explained how to test a tube for its strength to resist internal pressure by the apparatus according to the present invention.

First many tubes 30 are arranged in the rack 16. Then the arm 21 in the transferring mechanism 17 is moved over the rack 16, and a tube 30 is picked up by the chuck 22.

Secondly the tube 30 is transferred to a place just above the holder 12 by swinging the arm 21 by 90 degrees. At this time the holder 12 is set in a low position as shown in Fig. 1. Then the holder 12 is elevated by rotation of feed screw 14 to hold the tube 30 as shown in Fig. 4. The chuck 22 in the arm 21 releases the tube 30, and the arm swings back over the rack 16.

Thirdly the holder 12 that holds the tube 30 further elevates so that the tube 30 reaches the test head 4 in the test position as shown in Fig. 3. At the same time an expandable elastomer 5 is inserted into the tube 30. Then as disclosed before, fluid under a specific pressure provided via the open cavity 10 in the main body 8 fills the inside of the expandable elastomer 5 through holes of the rigid tube 9 to expand the expandable elastomer 5 and to exert a specific internal pressure to the tube 30. A tube 30 that does not stand the pressure is destroyed, and a tube 30 that passes the test remains as it is. The plastic sheet 11 prevents the upper part of the expandable elastomer 5 from unevenly expanding, thus preventing the tube

30 from being pushed in one direction to result in damage in a part close to the open end of the tube 30.

After the test, the holder 12 moves down to a certain extent so that the chuck 22 in the arm 21 in the transferring mechanism holds the tube 30 in the holder 12. Then the holder 12 moves down further, and the arm 21 brings back the tube to the rack 16. Then the table 18 is moved so that the arm 21 can pick up another tube 30.

When through testing many tubes a test head 4 wears or an expandable elastomer 5 deteriorates in elasticity, a test head 4 provided with pressurized fluid in a waiting position can promptly replace the test head 4 in the test position by rotating the rotary table 2. In this way tests can be continued with minimum interruption.

The apparatus according to the present invention can automatically and continuously test numerous tubes for its strength to resist internal pressure, overcoming disadvantages of the non-automatic, non-continuous apparatus previously disclosed. In addition to this feature, the apparatus as defined in claim 2 prevents potential damage in an area close to the open end of a tube to be tested by a plastic sheet surrounding an upper part of an expandable elastomer. Moreover, the apparatus in claim 3 enables to smoothly replace a test head 4 with an expandable elastomer with another test head 4 with an expandable elastomer with minimum interruption in a testing operation.

Claims

1. An apparatus for testing a tube for its resistance to internal pressure, comprising:
 - an expandable hollow elastomer body (5) with one open end;
 - means (8,10), connected to said expandable elastomer body (5), for providing said expandable elastomer body with a pressurized fluid medium;
 - means (12) for supporting a tube to be tested arranged for relatively vertical movement of the tube so that said expandable body (5) is inserted into the tube; and
 - means (17) for providing said means (12) for supporting a tube with a tube from a tube store (16).
2. An apparatus according to claim 1, further comprising a plastics material sheet (11) surrounding said expandable elastomer body (5) at a region thereof which is adjacent an open end of the tube to be tested in the test position, the sheet (11) being received in the tube.
3. An apparatus according to claim 1 or claim 2 hav-

ing a plurality of holders (4) for a plurality of said elastomer bodies (5) respectively, whereby the elastomer body (5) cooperating with said tube supporting means (12) is exchangeable.

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4. An apparatus as recited in any one of claims 1 to 3 wherein said means for providing pressurized fluid comprises a main body having a passage connected to the open end of said expandable elastomer body (5) and said tube supporting means (12) includes means for vertically moving a tube comprising a vertical feed screw (14), a holder (12) for holding a tube movably connected to said vertical feed screw, and means for driving said vertical feed screw.

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FIG. 1

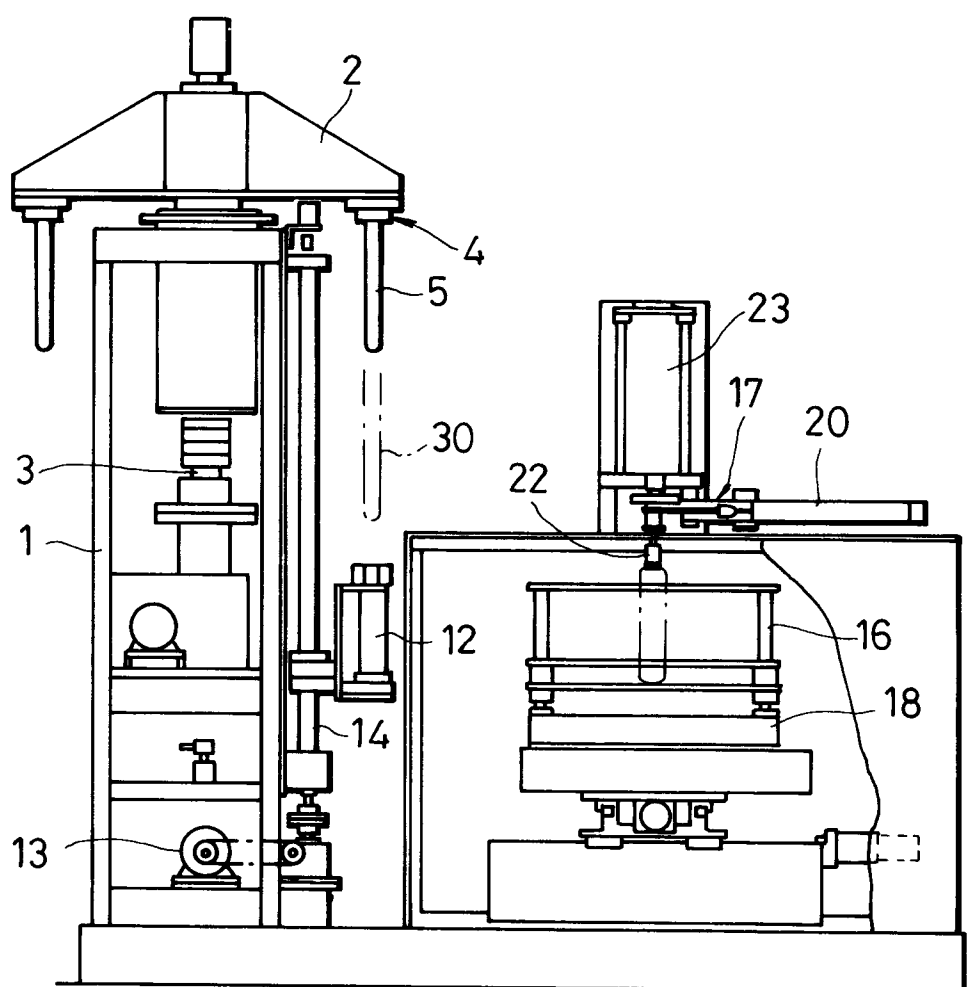


FIG.2

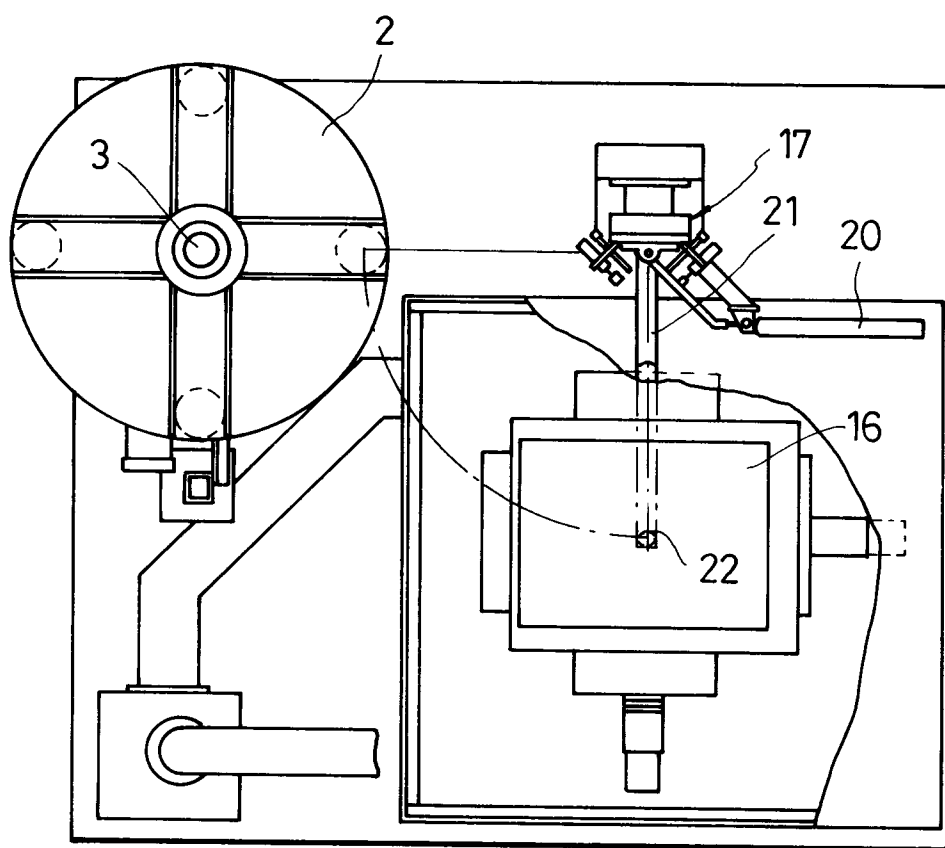


FIG. 3

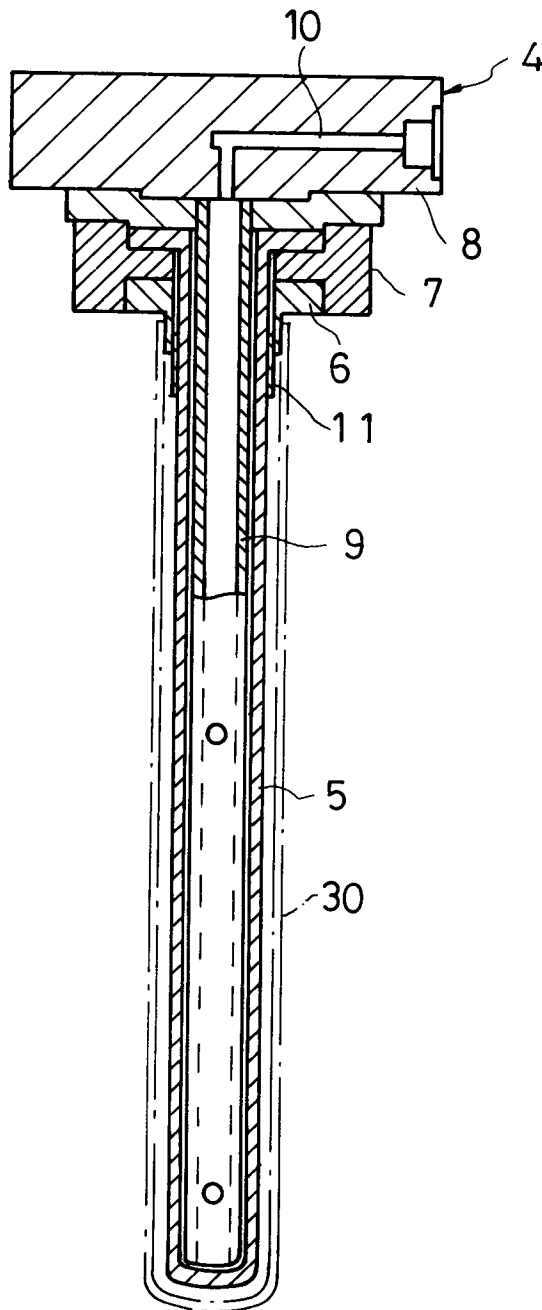


FIG. 4

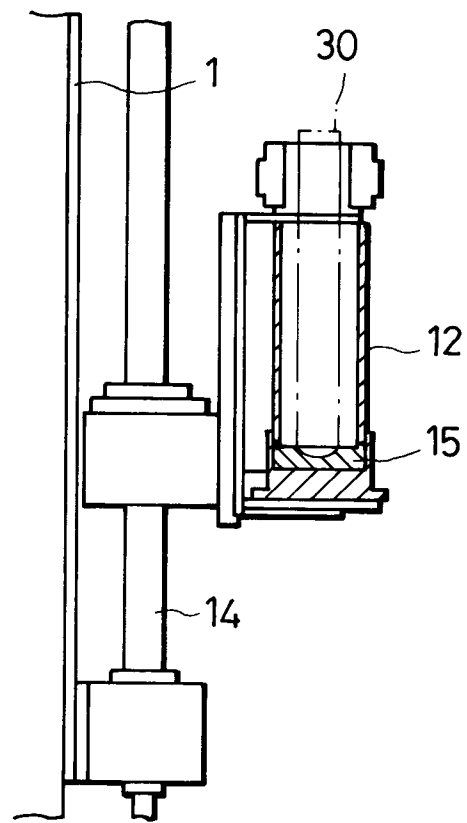


FIG. 5

